

**IMPROVEMENTS TO VACUUM FORMED INDEXABLE
LIGHTWEIGHT, RECYCLABLE TRAYS**

5

BACKGROUND OF THE INVENTION

This application is a continuation of U.S.
application Serial No. 09/617,401, filed July 17, 2000.

1. FIELD OF THE INVENTION

10 The present invention relates to improved
forms of moulded polymeric plastic material nursery
trays and also to methods of manufacturing same.

2. DESCRIPTION OF PRIOR ART

15 Traditionally nursery trays have been made
from three types of construction. The first is from
polystyrene foam, which due to the soft nature of the
material has had very limited use in automatic
transplanting machines. A second type of construction
has utilised vacuum forming techniques whereby a pre-
heated single sheet of plastic is formed by a known
20 vacuum forming process into a tray.

25 The nature of the previous methods of
manufacture and shapes achievable from the pre-heated
flat sheet were generally configured in a series of
cells and interconnected by a flat upper surface which
is sometimes formed downwardly around the outer
perimeter for a short distance and then blanked out
with a steel rule die to form an outwardly protruding
thin flange. Generally, these are not very accurate

for location or distance because of the flimsy nature of the vacuum formed tray and existing designs to date have not been suitable for automatic transplanting.

Injection die moulded hard plastic trays form
5 a third form of construction and have been able to be manufactured in complex shapes and sizes and by the nature of being moulded by fluid plastic injected into chilled dies. Material section thickness and shapes are readily obtainable to enable the trays to be used
10 in automatic transplanting machines, but by the nature of the complexity and cost of dies and the high capital costs of the moulding machines the relatively slow cycle time causing the costs to be such that the tray must be of a structure and design giving very long life
15 and repeated usage which requires arduous cleaning and sterilising processes between nursery usages.

SUMMARY OF THE INVENTION

It is an object of this invention to enable the usage of a very lightweight, low cost vacuum formed
20 tray to be used in automatic transplanting machinery, thereby providing precision plant placement with low labour cost. The invention preferably allows for a tray to be used effectively but because of its low cost, the tray may be used only once saving return
25 freight from point of supply, maintaining absolute hygiene at the nursery and preventing any introduction of disease by way of returning trays and very

importantly the invention provides for the ecologically friendly ability of the used tray to be recycled.

It is a further preferred objective to provide a nursery tray capable of use with automatic
5 transplanting machinery of the type disclosed in U.S. patent No. 6,327,986, which specification is incorporated herein by this reference thereto.

The present invention provides an indexable vacuum formed nursery tray made from a sheet of
10 polymeric plastic material having at least two aligned rows of indexing apertures formed in said sheet and a plurality of vacuum formed cells located between said rows of indexing apertures adapted to be filled with growing medium for plant propagation. Preferably, the
15 sheet of plastic material is preformed with zones of thicker plastic material with said indexing apertures being formed in a said zone of thicker plastic material prior to vacuum forming of said cells. Preferably the sheet of plastic material is formed via an extrusion
20 process which also includes providing at least some of said zones of thicker plastic material during the extrusion process.

Conveniently, the present invention also provides a nursery tray as aforesaid further including
25 transverse stiffening ribs of relatively thicker plastic material between at least some adjacent rows of said cells, said stiffening ribs being disposed

generally laterally relative to the rows of indexing apertures.

5 In accordance with one preferred nursery tray arrangement, a first said row of indexing apertures is provided on a first laterally extending flange portion on one peripheral side of the cells and a second said row of indexing apertures is provided on a second laterally extending flange portion on the other peripheral side of the cells, the nursery tray arrangement further having a depending stiffening flange portion extending downwardly from an outer edge of each of said first and second flanges towards a base region of the nursery tray arrangement. Preferably, the nursery tray arrangement further includes external or peripheral stiffening flange portions extending perpendicular to the stiffening flange portions located outwardly of the indexing apertures, the further stiffening flange portions being located at a peripheral edge of the outermost cells.

20 In accordance with another preferred nursery tray arrangement, a first said row of indexing apertures is provided in a bridging plastic material zone between adjacent said cells, and a second row of indexing apertures is provided spaced from said first row also located in a bridging plastic material zone between adjacent said cells. Multiple aligned said rows of indexing apertures may also be provided between

the bridging plastic material zones between adjacent
said cells, the number of said rows of indexing
apertures being any number more than two up to and
including all of the bridging plastic material zones
5 between adjacent cells. The indexing apertures are
conveniently preformed prior to vacuum forming the
cells. The shape and positioning of the indexing
apertures may be such as to cooperate with similarly
formed indexing wheel teeth on an indexing mechanism.
10 The apertures may be square, rectangular, circular or
any other convenient shape.

In one particularly preferred nursery tray
arrangement, a transversely formed trough is formed in
at least one bridging plastic material region between
15 adjacent rows of said cells, said trough or troughs
extending substantially across said nursery tray
laterally relative to said aligned rows of indexing
apertures. Conveniently the trough or troughs are
formed at the same time as the said cells, conveniently
20 also by vacuum forming techniques.

The present invention also provides a method
of forming a nursery tray having an array of
propagating cells with at least two aligned rows of
indexing apertures in spaced defined zones, said method
25 involving the steps of:

- (i) providing a sheet of plastic material having said
defined zones and capable of being formed;

(ii) forming said indexing apertures in said defined zones of said sheet;

(iii) restraining at least said defined zones to maintain a predetermined thickness of material in said defined zones; and

(iv) heating at least the remainder of said sheet and vacuum forming same to form said propagating cells without substantially reducing the thickness of said defined zones.

10 Preferably the sheet of plastic material may include thickened regions in a predetermined pattern relative to the remainder of said sheet of plastic material, said predefined pattern at least including said spaced defined zones. Advantageously, the

15 predefined pattern also includes regions intended to form stiffening ribs or formations in the tray.

 In accordance with a still further aspect, the present invention provides an indexing and plant eject arrangement for use with nursery trays of the

20 type including a plurality of cells arranged in predefined adjacent rows and at least two spaced aligned rows of indexing apertures generally perpendicular to said rows of cells, said arrangement including a guide means for guiding said trays along a

25 substantially vertical path downwardly past an eject mechanism, said guide means including edge restraining means to restrain lateral edge regions of the trays

during said downward movement, and a carrier mechanism moveable between a first position adopted to receive a plurality of seedlings or plants ejected from a said nursery tray and at least one second position adapted to discharge one or more seedlings from the carrier mechanism, said carrier mechanism in said first position being adapted to engage said tray to at least restrain movement of said tray forwardly or transversely of said path during transfer by said eject mechanism of seedlings or plants from said tray to said carrier mechanism.

Conveniently, at least two spaced indexing wheels are provided having indexing teeth adapted to engage said indexing apertures from and underneath side of said trays.

Preferably the arrangement may include one or more upright guide members adapted to be received between adjacent cells as the tray is indexed in a downward direction, the guide member or members engaging an underneath side of the tray. Preferably, a cross guide support means is also provided to restrain forward movement of the tray or portions of the tray during indexing and/or ejection stages.

Preferred aspects of this invention allow for the use of extruded plastic sheet material either in a parallel flat form or with strategic ribbons of thicker section linearly along the extruded sheet. The thicker

area of extrusion to be appropriately positioned to add stiffness and strength to the area in contact with the tray indexing mechanism.

5 In one preferred aspect, the invention provides for the unique forming of the shape of the upper surface of the tray that is interconnected to the cells positioned to be filled with growing medium for plant propagation. The unique features of the upper surface and sides of the tray which include preformed
10 engaging teeth and/or sprocket gear engaging apertures to very accurately contain and control the stepped/indexed descent of the lightweight thin sectioned tray at very high speeds.

15 Similarly, in a still further preferred aspect, the present invention provides for the interaction of mechanical means to prevent deflection, distortion and misplacement during both the indexing phase and the ejection of plants and plugs. The invention also provides for provision to enable the
20 lightweight vacuum formed tray to withstand the inertial shock loads caused by the sudden indexing for each row of cells to the next imposed on the trays when loaded with wet growing medium and live growing plants.

The claims as annexed hereto define the
25 invention and further form part of the disclosure of the present specification.

BRIEF DESCRIPTION OF THE DRAWINGS

There are shown in the drawings embodiments which are presently preferred it being understood, however, that the invention is not limited to the precise arrangements illustrated in the drawings, wherein:

Figure 1 is an underneath plan view of a first preferred embodiment, partially formed;

Figure 2a is a detail view of one edge region of the tray formation shown in Figure 1;

Figure 2b is a detail view similar to Figure 2a but showing the external edge flanges in a folded down position;

Figures 3 and 4 are side edge views of trays formed as shown in Figure 2b;

Figure 5 is a corner perspective view of the tray shown in Figures 1 to 4 but including a further preferred feature;

Figure 6 shows a tray in accordance with Figures 1 or 5 operatively engaged with an indexing mechanism;

Figure 7 shows a side/section view of the tray and indexing mechanism shown in Figure 6;

Figures 8 and 9 illustrate a possible modification to the indexing mechanism and tray indexing apertures shown in earlier drawings;

Figures 10 and 11 illustrate in upper plan view alternative embodiments for trays according to this invention.

Figures 12 and 13 illustrate in partial section view, the trays of Figures 10 and 11 engaged with indexing mechanisms;

Figure 14 illustrates in underneath plan view a still further preferred tray embodiment;

Figures 15 and 16 illustrate in partial section vies, the tray of Figure 14 engaged by an indexing mechanism;

Figure 17 shows in perspective view a corner region of yet another preferred tray embodiment;

Figures 18 and 19 are respectively section and side edge views of the tray shown in Figure 17;

Figures 20 and 21 are partial section views showing the tray of Figure 17 engaged with an indexing mechanism;

Figure 22 shows in section view the tray of Figure 17 cooperatively engaged with an indexing mechanism and equipment for ejecting plants from the tray and further handling same;

Figure 23 shows in top plan view a preferred support structure capable of use when indexing trays as disclosed herein;

Figure 24 illustrates in side view a possible further modification to indexing mechanisms as disclosed herein; and

Figures 25 and 26 illustrate in plan view and
5 in side view with a cooperating indexing mechanism, a still further preferred tray embodiment.

**DETAILED DESCRIPTION OF THE
PREFERRED EMBODIMENTS**

10 Figure 1 shows a plan view in one preferred embodiment where a plastic sheet can be formed into a tray 10, the sheet being blanked out to form the outer flanges (1) and the open top indexing notches or
15 apertures (2) from the full material thickness of the sheet. This sheet has not been deformed and thinned out by the vacuum forming process and has a clear cut outer edge free for flanges which normally occurs from the traditional vacuum forming process. The pre-heated pre-formed component can then be blown with outside
20 edges being restrained causing the entire sheet which is not restrained to form a bubble which uniformly stretches the area of the tray to be formed into cells each of which has an open top which is co-planar with the other cells and with the flange (1) which contains
25 the indexing notches. This slack pre-heated sheet is then uniformly distributed and pushed into the vacuum forming cell shapes by protruding mechanical rods pushing the plastic sheet from the upper surface down

into the cell cavities. Vacuum is then applied to the underside of the sheet to speedily conform the plastic sheet to the required die shape. Importantly the pre-heated outer edges (3) of the sheet flanges 1 are
5 formed downwardly to the correct angle to give stiffness. The outer edges area (1) containing the gear teeth engaging notches (2) being mechanically formed and composed of the original thickness of the plastic sheet which gives great rigidity with this
10 thicker material forming a support edging on all four sides.

Figure 2(a) is an elevation as viewed from the underside of the tray, which shows the location of the indexing notches (2) relevant to the centre line of
15 the cells 94). It also shows the positioning of the end of the trays allowing indexing tray to tray to be maintained at a uniform distance cell to cell across the tray and tray to tray. This is accomplished by each gear engaging in a series of holes at each side of
20 the tray, both on the centre line of the cell and between the cells to provide tray control and containment when indexing from tray to tray.

Figure 2(b) shows the same tray with the outside flanges (3) folded down to form the main
25 stiffening members.

Figure 3 shows the flanges (1) and (3) that provide for the support of the tray. This design

allows for the indexing gears to enter from the rear of the tray, therefore providing good mechanical engagement and control without contact or damage occurring to plant foliage on the upper side of the tray (see Figure 6).

Figure 4 shows an end elevation of the support edges (3) of the tray (10) when vertically resting against the next tray (10') during the indexing cycle, which enables uniformity of, cell placement tray to tray.

Figure 5 shows in one preferred embodiment the tray as described in Figures 1 to 4 which further includes an inverted rib (21) in a series of locations across the tray to add depth and therefore stiffness.

In one preferred embodiment (Figure 1) the two side areas of the tray including the flange area (1) which contains the gear engaging notches (2) can have additional thickness effected by the linear extrusion of the sheet with that area being a thicker thickness than that of the rest of the tray.

Figures 6 and 7 illustrate a practical embodiment of an indexing mechanism capable of use in the present invention that is mechanically restrained by means of a common torque tube or shaft (6) with indexing gears (7) that engage through the notches (2) which form a rack in the sides of the tray.

Figures 8 and 9 show another preferred embodiment utilising a different form of indexing gear and shape of notch to that which is described in detail with reference to Figures 1 to 7. Figures 8 and 9 show the restraining mechanisms being formed by a sprocket wheel or gear 7 having circular tapered engagement sprocket teeth (8), which engage in circular holes (9) in the engagement rack (51) formed at the ends of the tray (10'). The circular tapered teeth (8) provide, not only alignment entry and exit in the vertical plane but also in the horizontal plane. Figure 9 is a partial section view, viewed from the underside of the tray (10'').

In another simple embodiment of the invention (Figure 10), a vacuum formed tray includes cells (11) shaped with chamfered corners (50) that allow sufficient space in an upper flange zone between the corners of four adjacent cells to provide a sprocket engaging aperture (12). Figure 10 shows a tray with circular sprocket engagement apertures (12) and Figure 11 shows a tray with square or rectangular sprocket engaging apertures (13). Figures 12 and 13 show a section through trays of the type shown in Figures 10 and 11 essentially between the cells of adjacent cell rows, Figure 13 being a section view at 90° to the section of Figure 12. The arrangement utilises

multiple sprocket or gear wheels 7 each engaging with a respective row of apertures (12) or (13).

Figure 14 shows another preferred embodiment (as viewed from the underside of the tray) of the tray with an extra row of round holes (37) down two external edges in the direction of indexing and also shows two flanges (38) folded down two external edges which gives the ray longitudinal stiffness. The number of holes may also be doubled by adding holes (32) in between the holes 937) located at the intersection of the flanges between adjacent cells. The shape of the holes may be circular as shown, or they may be square, rectangular or otherwise to cooperate with suitably shaped teeth of the sprocket or gear wheels.

Figures 15 and 16 show a section through a portion of the tray of Figure 14 showing the drive, sprocket/gear (40) engaging in square or rectangular holes (32, 37) of the tray described in Figure 14.

Figure 17 shows a corner region of a vacuum formed tray including stiffening edge flanges (15) with channels (16) being formed between adjacent rows of cells (17) from the outer stiffener flanges (15) from either side of the tray. These stiffener channels (16) can be placed between one or more of the cells. Within flange regions between adjacent cells (17), are sprocket gear notches (13) which are used with multi indexing sprockets (see Figures 20 and 21).

Figures 18 and 19 show respectively a section view and an edge view of the tray of Figure 17 showing the channels (16), which serve a multi purpose and provide strength and stiffness to the tray. They also provide an engaging gear rack means as shown in Figure 20, which can be used singularly and/or in combination with apertures for the gear engaging means shown.

Figure 20 shows the stiffening channels (16) (as viewed from the side) engaging in the sprocket notch (18) while the sprocket teeth (19) enter and exit through the notches (13).

Figure 21 is a section view (as viewed from the top) showing a multiple gear (7) engagement spreading uniform load restraint across the full width of the tray (20). It will be appreciated that the invention provides for the utilisation of either the multiplicity of sprockets engaging in the holes only, or engaging on the stiffening ribs only or a combination of the two.

Figure 22 shows the tray (21) in the engaged position for the ejection of the plug comprising a growing medium and plant (22) from the tray (21) into the plant receptacles (23) on a conveyor (24) intended to transfer the seedlings to a plant delivery and planting machine. The tray, in one preferred embodiment (Figure 23) is restrained by external flanges (25) on the tray being held within a vertical

slot (26) in which the tray slides in a downward direction when being indexed by the indexing sprocket wheels. The tray may also be restrained by thin vertical slides (28) which fit in between the cells (29) on the inside of the tray (21). A further external restraining bar (30) Figure 22 may be located on the outside to stop the tray from moving outwardly or transversely of the vertical path of movement of the tray when plant ejection occurs. This restraining bar (30) is positioned to clear the conveyor when it swings away on arc (35) after loading a full row of plants. At the time of plant ejection the plant ejection bars (31) move inwardly and push the plug/plant (22) from the tray and into the waiting receptacles (23) on the conveyor (24). On ejection any forward movement of the tray caused by the eject bars is arrested by the plant receptacles (23) on the conveyor (24) which are in close proximity to the tray (21) when in the loading position as in Figure 22.

Figure 24 shows a side elevation of two trays (32) and (33) in the vertical position being indexed downwardly by means of sprocket/gear (34). This sprocket/gear is positioned at the plant eject location as discussed with reference to Figure 22, and is mechanically connected to a second sprocket/gear (35) via chain (36) or other means. This second sprocket/gear (35) is positioned so that both trays are

engaged in an indexing means at all times. This ensures the accurate precise indexing of trays.

Figures 25 and 26 show a tray in the same configuration as that shown in Figure 14 the only difference being that the fold down flange (38) shown in Figure 14 is now a flat flange (41) being an extension of the top surface of the tray (42). Figure 25 is plan elevation of the tray showing horizontal flanges (41). During the downloading, indexing and plant eject sequences of the trays, the trays (43) (Figure 26), are contained in slots (44) which act as guides while the indexing sprockets/gears (45) engage with the tray and move it downward (see Figure 22).

In all of the embodiments the open ends of the cells are co-planar with one another and with the thicker sections in which the indexing openings are formed.

The disclosed embodiment is representative of a presently preferred form of the invention, but is intended to be illustrative rather than definitive thereof. The invention is defined in the claims.